

REMARKS

Claims 1, 3-26, 37-42, and 45-47 are currently pending. Claim 1 has been amended. New Claim 47 has been added. Claims 2, 43, and 44 have been canceled. Support for the new claim is found in the specification and claims as filed.

Claim Rejection - 35 U.S.C. § 102(c) - Stalmans et al.

Claims 1, 3-23, 26, 37-38, 40-42, and 45-46 have been rejected under 35 U.S.C. §102(e) as anticipated by U.S. 6,683,367 (Stalmans et al.). "A rejection for anticipation under section 102 requires that each and every limitation of the claimed invention be disclosed in a single prior art reference." *See, e.g., In re Paulsen*, 31 U.S.P.Q.2d 1671 (Fed. Cir. 1994). Stalmans et al. does not disclose every element of Applicants' claims, and therefore cannot be considered as an anticipating reference under 35 U.S.C. § 102(b).

Pending independent Claim 1 recites a photovoltaic device comprising, *inter alia*, "a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm." Stalmans et al. teaches a porous layer having a thickness of 0.1 to 1 micron (100 to 1000 nm). Thus, Stalmans et al. does not disclose a third layer having a thickness of from about 1 nm to about 50 nm, and therefore cannot anticipate Claims 1, 3-23, 26, 37-38, 40-42, and 45-46.

Moreover Stalmans et al. does not disclose a device wherein "the third layer comprises a porous layer of high transparency" (Claim 45) or a device wherein "the third layer consists of a transparent porous layer" (Claim 46). The Office Action asserts that "the porous silicon layer of Stalmans et al. can be highly transparent, because the degree of transparency depends on the porosity of the porous silicon layer." As discussed in Dr. Poortmans' declaration, a statement that light can pass through a medium comprising pores by propagation through the pores does not apply to the device of Stalmans et al. When the pore size is substantially lower than the wavelength (which is the case in the devices of the cited art), light propagation occurs by phenomena of interference and dispersion, and therefore primarily depends on the effective index of refraction of the porous layer and its thickness, not the presence of pores themselves. The layer of Stalmans et al. with the disclosed thickness and porosity would not be considered "transparent" or of "high transparency" by one of skill in the art.

Accordingly, Applicants respectfully request that the rejection be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Stalmans et al. in view of Fathauer et al.

Claims 2, 24, 25, 39, and 43-44 have been rejected under 35 U.S.C. §103(a) as obvious over Stalmans et al. in view of U.S. 5,757,024 (Fathauer et al.). To establish a *prima facie* case of obviousness, three basic criteria must be met: first, the prior art reference (or references when combined) must teach or suggest all the claim limitations; second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; finally, there must be a reasonable expectation of success. See M.P.E.P. § 2143. As discussed above, Stalmans et al. does not teach or suggest “a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm.” Fathauer et al. is cited for teaching a porous silicon-containing layer having a thickness of 5 to 20 nm.

There is no suggestion or motivation in either Stalmans et al. or Fathauer et al., or in the knowledge generally available to one of ordinary skill in the art, to combine these references’ teachings, as discussed in detail in the Declaration of Jef Poortmans. The Office Action asserts that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Stalmans et al. by having the thickness of the porous layer of about 5 nm to about 20 nm as taught by Fathauer et al, because it would eliminate detrimental porosification in the non-porous silicon layers. Fathauer et al. produces light emitting devices by making a stack of alternating layers of Si and SiGe, which are then patterned into mesa structures. Thereafter, a stain etch is applied to the stack, resulting in the porosification of the SiGe layer. In col. 3, lines 25-31 of Fathauer et al., a thicker SiGe layer is linked with detrimental porosification of the silicon layers in the stack by stain etching. Stalmans et al. does not use stain etching in preparing their device, and moreover the Stalmans et al. device does not include any silicon layers which would be detrimentally impacted by this type of stain etching process. Accordingly, there is no motivation or suggestion to combine Stalmans et al. with Fathauer et al., because detrimental porosification is not a problem in Stalmans et al. Because there is no

teaching, suggestion, or motivation to use a thinner porous layer as in Fathauer et al. in the device of Stalmans et al., a prima facie case of obviousness cannot be established.

Moreover, there is also no reasonable expectation of success in making the combination of Stalmans et al. and Fathauer et al., in that the proposed combination results in the Stalmans et al. device being unsatisfactory for its intended purpose. If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. *See* M.P.E.P. § 2143.01 V. *See also, In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984) (stating that “The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification.”).

Stalmans et al. teaches a porous layer having a thickness of 0.1 to 1 micron (100 to 1000 nm). As discussed in the Declaration of Jef Poortmans, Stalmans et al. uses a thick porous layer to minimize transmission of light, as reflectance and diffusion are desired. The porous layer of Stalmans et al. should allow as little as possible light to pass through. Of course, one cannot avoid losing a very small part of the light through the layer, as indicated by the arrow of Figures 1(a) and 1(b). A thicker layer as is employed in the device of Stalmans et al. is expected to give a higher reflectance, which is a desirable feature in the Stalmans et al. device. In Dr. Poortmans’ declaration, data from simulations is provided that show that a maximum of 18 % reflectance at normal incidence is observed for a 60 % porosity porous silicon layer of 50 nm thickness. For thinner layers, the reflectance is even lower, e.g., 9 % for a layer of 30 nm thickness. Reflectances of more than 70 % are typically needed for the Stalmans et al. device. A porous layer with a thickness of from about 1 nm to about 50 nm, as presently claimed, would not sufficiently reflect the light and would not be thick enough to give sufficient light confinement for the device of Stalmans et al., and thus would be unsuitable for use in the Stalmans et al. device. Moreover, in Stalmans et al., light transmission is undesirable, because the active device is on top of the porous layer, and therefore light absorption is maximized in the layer on top of the porous layer. In contrast, in the invention as presently claimed, light absorption occurs below the porous layer, and is preferably as high as possible.

Because there is no teaching, motivation, or suggestion to combine Fathauer et al with Stalmans et al. and because there is no reasonable expectation of success in modifying Stalmans

et al. with Fathauer et al., a prima facie case of obviousness cannot be established. Even if a prima facie case of obviousness could be established, it would be rebutted because the proposed modification of the Stalmans et al. device to include the porous layer of Fathauer et al. would render the Stalmans et al. device unsatisfactory for its intended use. Accordingly, Applicants respectfully request that the rejection of the claims be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Stalmans et al. in view of Iwamoto et al.

Claim 39 has been rejected under 35 U.S.C. §103(a) as obvious over Stalmans et al. in view of U.S. 5,066,340 (Iwamoto et al.). To establish a *prima facie* case of obviousness, the prior art reference (or references when combined) must, *inter alia*, teach or suggest all the claim limitations. See M.P.E.P. § 2143. As discussed above, Stalmans et al. does not teach or suggest “a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm.” Iwamoto et al. is cited for teaching an intrinsic multicrystalline layer sandwiched between a p-type multicrystalline silicon layer and an n-type amorphous silicon layer. Iwamoto et al. does not, however, include teachings overcoming the deficiencies of Stalmans et al., namely, a teaching as to a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm. Accordingly, a prima facie case of obviousness cannot be established and Applicants respectfully request that the rejection of the claim be withdrawn.

Claim Rejection - 35 U.S.C. § 102(b) - Yamada et al.

Claims 1, 3, 4-23, 38-42, and 45-46 have been rejected under 35 U.S.C. §102(b) as anticipated by U.S. 5,331,180 (Yamada et al.). “A rejection for anticipation under section 102 requires that each and every limitation of the claimed invention be disclosed in a single prior art reference.” See, e.g., *In re Paulsen*, 31 U.S.P.Q.2d 1671 (Fed. Cir. 1994). Yamada et al. does not disclose every element of Applicants’ claims, and therefore cannot be considered as an anticipating reference under 35 U.S.C. § 102(b).

Pending independent Claim 1 recites a photovoltaic device comprising, *inter alia*, “a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm.” Yamada et al. teaches

porous layers of a thickness of 1 micron (1000 nm) and 1000 Å (100 nm). Thus, Yamada et al. does not disclose a third layer having a thickness of from about 1 nm to about 50 nm, and therefore cannot anticipate Claims 1, 3, 4-23, 38-42, and 45-46.

Moreover Yamada et al. does not disclose a device wherein “the third layer comprises a porous layer of high transparency” (Claim 45) or a device wherein “the third layer consists of a transparent porous layer” (Claim 46). As discussed above in regard to the §102(e) rejection over Stalmans et al., and for the same reasons, the layers of Yamada et al. with the disclosed thicknesses and porosities would not be considered “transparent” or of “high transparency” by one of skill in the art.

Accordingly, Applicants respectfully request that the rejection be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Yamada et al. in view of Fathauer et al.

Claims 2, 24, 25, and 43-44 have been rejected under 35 U.S.C. §103(a) as obvious over Yamada et al. in view of Fathauer et al. To establish a *prima facie* case of obviousness, three basic criteria must be met: first, the prior art reference (or references when combined) must teach or suggest all the claim limitations; second, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings; finally, there must be a reasonable expectation of success. See M.P.E.P. § 2143. As discussed above, Yamada et al. does not teach or suggest “a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm.” Fathauer et al. is cited for teaching a porous silicon-containing layer having a thickness of 5 to 20 nm.

There is no suggestion or motivation in either Yamada et al. or Fathauer et al., or in the knowledge generally available to one of ordinary skill in the art, to combine these references’ teachings, as discussed in detail in the Declaration of Jef Poortmans, and for the same reasons as discussed above in connection with the rejection over Stalmans et al. and Fathauer et al. under §103(a). The Office Action asserts that it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Yamada et al. by having the thickness of the porous layer of about 5 nm to about 20 nm as taught by Fathauer et al, because it

would eliminate detrimental porosification in the non-porous silicon layers. Yamada et al. does not use stain etching in preparing their device, and moreover the Yamada et al. device does not include any silicon layers which would be detrimentally impacted by this type of stain etching process. Accordingly, there is no motivation or suggestion to combine Yamada et al. with Fathauer et al., because detrimental porosification is not a problem in Yamada et al. Because there is no teaching, suggestion, or motivation to use a thinner porous layer as in Fathauer et al. in the device of Yamada et al., a prima facie case of obviousness cannot be established.

Moreover, there is also no reasonable expectation of success in making the combination of Yamada et al. and Fathauer et al., in that the proposed combination results in the Yamada et al. device being unsatisfactory for its intended purpose. If the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. See M.P.E.P. § 2143.01 V. See also, *In re Gordon*, 733 F.2d 900, 902 (Fed. Cir. 1984) (stating that "The mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification.").

Yamada et al. teaches porous layers of a thickness of 1 micron (1000 nm) and 1000 Å (100 nm). As discussed in the Declaration of Jef Poortmans, Yamada et al. concerns a light emitting device, which comprises a porous layer. The thickness of this porous layer must *a priori* be as thick as possible, since this would produce more light. The thickness must be such though, that charge carrier injection in the layer can efficiently be performed. The thickness disclosed in Yamada is a balanced thickness which allows enough charge injection together with enough light emission. If Yamada were to employ thinner layers, e.g., a thickness of 1-50 nm, there would be a lot less light generated, meaning a reduction in the performance of the device. The proposed modification of the Yamada et al. device to include the porous layer of Fathauer et al. would therefore render the Yamada et al. device unsuitable for its intended purpose.

Because there is no teaching, motivation, or suggestion to combine Fathauer et al with Yamada et al. and because there is no reasonable expectation of success in modifying Yamada et al. with Fathauer et al., a prima facie case of obviousness cannot be established. Even if a prima facie case of obviousness could be established, it would be rebutted because the proposed modification of the Yamada et al. device to include the porous layer of Fathauer et al. would

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render the Yamada et al. device unsatisfactory for its intended use. Accordingly, Applicants respectfully request that the rejection of the claims be withdrawn.

Claim Rejection - 35 U.S.C. §103(a) - Yamada et al. in view of Stalmans et al.

Claims 26 and 37 have been rejected under 35 U.S.C. §103(a) as obvious over Yamada et al. in view of Stalmans et al. To articulate a *prima facie* case of obviousness under 35 U.S.C. §103(a), the PTO must, *inter alia*, cite prior art that teaches or suggests all the claimed limitations. *In re Royka*, 490 F.2d 981 (C.C.P.A. 1974). As discussed above, neither Yamada et al. nor Stalmans et al. discloses a third layer comprising a third semiconductor material, wherein the third layer is situated between the first layer and the second layer, and wherein the third layer is a translucent porous layer and diffusion barrier having a thickness of from about 1 nm to about 50 nm. Accordingly, a *prima facie* case of obviousness cannot be established, and Applicants respectfully request that the rejection be withdrawn.

Conclusion

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is in condition for allowance. Should the Examiner have any remaining concerns that might prevent the prompt allowance of the application, the Examiner is respectfully invited to contact the undersigned at the telephone number below.

Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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